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HERPETOLOGICAL FAUNA OF MOUNT MAKILING[1]

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The faunal survey which has been proposed for the Mount Makiling Forest Reserve is a noteworthy plan. In view of this proposed survey it seems worth while to record a list of species of the amphibia, turtles, lizards, and snakes now known to occur on Mount Makiling and about its base.

The following records are based on collections of the College of Agriculture and the Forest School, made by the faculties and students of the two institutions; and on various collections made by me at intervals between 1914 and 1922.

The list of species represents the characteristic reptilian and amphibian fauna but it should not be regarded as complete. It is quite probable that other known species as well as new species will be found to occur on the mountain. Few collections have been made at high elevations, and it is there that the collector will probably find most species as are included in the Makiling fauna and not recorded in this list.

TURTLES

Cyclemys amboinensis (Daudin).

This turtle is not uncommon along the Molawin, a small creek which flows through the campus of the College of Agriculture. Specimens are occasionally found away from water in the forest. Males and females show much variation in the shape of the carapace but they are uniform in head markings. Many specimens collected.

AMPHIBIANS

Key to species of amphibians found on Mount Makiling.

a[1] Upper jaws with teeth (Family RANIDÆ).

b[1] Tongue oval, entire, without a notch in posterior part—OXYGLOSSIS LÆVIS Günther.

b[2] Tongue deeply notched behind.

c[1] Toes more or less webbed, with or without pads on toes and fingers; no web between fingers.

d[1] No pads on toes or fingers.

e[1] No free skin flap on outer side of fifth toe and metatarsus —RANA MOODIEI Taylor.

d[2] Small rounded pads on tips of toes and fingers.

[1] Experiment Station Contribution No. 100.

e^1 Toes almost fully webbed; no dorsolateral dermal folds; no distinctive spot on tympanum; very large frogs—RANA MAGNA Stejneger.

e^2 Toes about three-fourth webbed; narrow dorso-lateral folds present in both young and adults; a distinctive spot on tympanum; medium size—RANA WOODWORTHI[1] Taylor.

e^3 Toes about two-thirds webbed, no dorsolateral folds; two bronze or cream colored dorso-lateral stripes, usually meeting on tip of snout—RANA SIMILIS (Günther).

c^2 Toes strongly webbed; fingers with or without webs; tips of digits of hands and feet with very broad adhesive disks; arboreal frogs.

d^1 Fingers with well developed web; body mottled gray or reddish brown—POLYPEDATES PARDALIS (Günther).

d^2 Fingers almost entirely without web; body marked with six longitudinal dark stripes or with a few scattered spots—POLYPEDATES LEUCOMYSTAX (Gravenhorst).

c^3 Fingers and toes with rounding tips and without webs.

d^1 Elongate, narrow, curved, folds on shoulders beginning behind eye; gray to reddish above, dark on sides of head and body—CORNUFER CORRUGATUS (Duméril).

d^2 Numerous rounded or elongate tubercles on back; extremely variable in color and markings—CORNUFER MEYERI (Günther).

a^2 No teeth in upper jaw (Family BREVICIPITIDÆ).

b^1 Fingers and toes with small rounded tips—KALOULA PICTA (Bibron).

b^2 Fingers dilated at tips into broad truncate disks—KALOULA BALEATA (Müller).

Family RANIDÆ

Oxyglossis lævis Günther.

This species is found in the mountain streams and in rain pools scattered through the forest. The frogs are almost invariably found in water or among rotting leaves about the forest. I have collected numerous specimens up to nearly 500 meters elevation. They probably occur at higher elevations.

Rana moodiei Taylor.

This species is confined to the lowlands. It is not rare along Molawin creek. I have never found it at an elevation higher than the Forest School. Many specimens collected.

Rana vittigera Wiegmann.

This species, like the preceding, is a lowland form, usually found in moist situations. I have never taken it at an elevation higher than the Forest School.

Rana magna Stejneger.

This large species is found along the mountain brooks and streams. The adults reach a large size. They are usually seen perched along the banks of the streams. They take to the water at the least disturbance, and remain under water several minutes. Several specimens collected.

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[1] The description of this species is in press in *Philippine Journal of Science.*

Rana woodworthi Taylor.

This species is common along the mountain streams at low elevation. I collected an excellent series in one of the streams running about midway between Camp Eldridge and the College of Agriculture. The stream was nearly dry and the frogs had congregated in the small stagnant pools. Many specimens taken.

Rana similis (Günther).

Los Baños is the type locality of this species.

I have collected a number of specimens in the small stream which empties into Laguna de Bay near Los Baños. They are usually found near water, concealed under logs, rocks or heavy undergrowth. They rarely take to water to escape capture, and if they do enter the water, they do not remain below the surface any considerable length of time. In color they are bronze to blackish above, with two cream or yellow lines along each side of the body. Many specimens taken.

Polypedates pardalis (Günther).

I have examined only a single specimen of this rare frog from Mount Makiling. It is in the collection of the Forest School. It is a shy form, usually found in trees or in the axils of banana and abaca leaves. It may be identified easily by the webbed hand. It is a rather large form. The eggs are laid in balls of yellow foam about rain pools or small brooks.

Polypedates leucomystax (Gravenhorst).

This is the common tree frog and occurs chiefly at low elevation. I have not taken it above 500 meters. The large pads on the tips of the fingers and toes make this and the preceding species easily recognized. This species, however, has no conspicuous web between the fingers. Specimens vary in markings. Many specimens have six, broad, dark lines on the back; others have only a few irregular spots. The eggs are laid in masses of creamy white foam in the edge of water or on branches of trees and shrubs extending over the water. Many specimens taken.

Cornufer corrugatus (Duméril).

This species probably occurs to the top of the mountain since I have taken it at a point within 200 meters of the summit. It is a woodland form and is rarely found in the vicinity of water. Specimens vary greatly in color. Individuals may be either red, white, gray, orange, flesh, or brown. The regular, elongate folds on the anterior part of back are usually evident. Many specimens collected.

Cornufer meyeri (Günther).

"Los Baños" is given as the type locality for this species. It is very common. The young are usually found along the streams; the adults are found moving about in the forest. The individuals vary greatly in color and markings and rarely can two specimens be found that are alike. This and the preceding form may be distinguished from other Makiling frogs by the slender fingers and toes without widened pads or webs. They probably occur to the summit of the mountain. It is not improbable that more than one closely re-

lated species is represented in the large series of specimens taken, all of which I have designated *Cornufer meyeri* for want of stable characters to differentiate the color forms.

Family BREVICIPITIDÆ

Kaloula picta (Bibron).

This narrow-mouthed toad is not uncommon at low elevations. It is nocturnal in habit, usually burrowing under loose earth in the day time. It apparently does not approach water, save during the breeding season when many individuals congregate about rain pools to lay their eggs. Many specimens collected.

Kaloula baleata (Müller).

This species has been reported from Los Baños. A specimen collected by Dr. Meyer is in the British Museum. I collected a single very young specimen, which I have identified as this species, in the small stream which empties into Laguna de Bay near Pansol. The species differs from the preceding one in having broadened pads on the fingers and toes. Only these two specimens have been taken.

LIZARDS

Key to lizards known from Mount Makiling.

a^1 Body without scales except on belly (Family GEKKONIDÆ).

b^1 Tips of digits not dilated; adhesive pads absent—GYMNODACTYLUS PHILIPPINICUS Steindachner.

b^2 Tips of digits dilated; adhesive pads present.

c^1 Body and tail with numerous low spiny tubercles, (Small house geckoes)—HEMIDACTYLUS FRENATUS Duméril and Bibron.

c^2 Body without tubercles;

d^1 A flap of skin along the sides of belly—COSYMBOTUS PLATYURUS (Schneider).

d^2 No skin flap on sides of body.

e^1 Tail semi-cylindrical without serrate edge—PEROPUS MUTILATUS (Wiegmann).

e^2 Tail flattened with serrate edge—HEMIDACTYLUS GARNOTII (Duméril and Bibron).

c^3 Body without rounded tubercles; latter becoming trihedral on tail; large geckoes (*tukko*)—GEKKO GECKO (Linnæus).

a^2 Body covered with scales.

b^1 Tongue not forked. Head short.(Family AGAMIDÆ).

c^1 Broad lateral expansion of skin supported by ribs, used as wings —DRACO SPILOPTERUS (Wiegmann).

c^2 No dermal expansion.

d^1 Body somewhat compressed, with tail extremely long, slender; usually green in color; a spiny nuchal crest present in adults —CALOTES MARMORATUS (Gray).

d^2 Large lizards with a slight nasal crest; a serrate nuchal crest, and a fan shaped crest on tail; crest very large in adult males (*Iguana, balubid*)—HYDROSAURUS PUSTULOSUS (Eschscholtz).

b² Tongue forked; body covered with juxtaposed scales; large black and yellow lizards (*bayawak*) (Family VARANIDÆ)—VARANUS SALVATOR (Laurenti).

b³ Tongue not forked; body covered with shiny imbricating scales (Family SCINCIDÆ).

c¹ Scales with numerous low keels.

d¹ No postnasal scale; body scales iridescent, with 5 or 7 keels—MABUYA MULTICARINATA (Gray).

d² A postnasal scale; body scales olive to olive brown, with 3 or 5 keels. Females sometimes with small light dots on sides of body—MABUYA MULTIFASCIATA (Kuhl).

c² Scales smooth.

d¹ Legs well developed, pentadactyl.

e¹ No supranasals.

f¹ Prenal scales enlarged.

g¹ No enlarged nuchal scales present; brown color; terrestrial.

h¹ Form diminutive; length about 75 mm. No distinct lateral stripes; uniform light brown —SPHENOMORPHUS STEEREI Stejneger.

h² Form small; length about 110 mm.; distinct lateral stripe—SPHENOMORPHUS CURTIROSTRIS Taylor.

h³ Size large; length 250mm.; broken lateral dark line present or absent—SPHENOMORPHUS JAGORI JAGORI (Peters).

g² Nuchal scales present; small size; length 110 mm. A median golden line; arboreal—LEIOLEPISMA PULCHELLUM Gray.

f² Preanals not enlarged; arboreal; reaching a length of 270 mm.—DASIA SMARAGDINUM (Lesson).

e² Supranasals present; a large species attaining a length of 360 mm. Large spots on sides in a longitudinal row —OTOSAURUS CUMINGII Gray.

d² Limbs pentadactyl, poorly developed; digits very small; scales hard, shiny; a burrowing form—BRACHYMELES BOULENGERI Taylor.

d³ Limbs minute, without digits—BRACHYMELES BONITÆ Duméril and Bibron.

c³ Scales with a single heavy keel; semi-aquatic skinks; length 190—TROPIDOPHORUS GRAYI Günther.

Family GEKKONIDÆ

Gymnodactylus philippinicus Steindachner.

Occurs in the forest under logs, and under loose bark of trees. It is, so far as I know, never found in houses. It may be easily distinguished from other geckoes by the long slender digits terminating in sharp claws, and in the absence of adhesive laminæ under the toes.

Hemidactylus garnotii Duméril and Bibron.

A rare species of house gecko. Only one specimen collected.

Hemidactylus frenatus Duméril and Bibron.

Common in the houses and in lowland forest. Many specimens collected. This species is the one most frequently found in the houses.

Cosymbotus platyurus (Schneider).

A common house gecko. It is rarely if ever found in the forest. It may be easily distinguished by the loose flap of skin along the sides of abdomen. Many specimens collected.

Peropus mutilatus (Wiegmann).

A common gecko found in houses. It is also common in lowland forest. Many specimens collected.

Gekko gecko (Linnæus)

The call of this large gecko may be heard in the forest at low elevations, and not infrequently in the houses. It is widely known in the Philippine dialects as *to-co* or *tuk-ko*. It is probably confined to the lowlands everywhere in the Philippines. Many collected.

Family AGAMIDÆ

Draco spilopterus (Wiegmann).

This species of flying lizard is not rare in the lowland forest. I collected several specimens in the trees near the nursery of the Forest School. So far as is known it is the only species of *Draco* on Mount Makiling. Males and females differ considerably in color and markings. Many collected.

Calotes marmoratus (Gray).

This species has been collected several times about the base of Mount Makiling. Nowhere does it seem common. It is usually found in trees or shrubs, rarely descending to the ground. The usual color is bright green. However, color changes are made with great rapidity, and a bright green specimen may become a dull brown in a few minutes. Males and females differ in the height of the dorsal spiny crest.

Family VARINIDÆ

Varanus salvator (Laurenti).

This large *bayawak* is common on Mount Makiling at low elevation. It is a widely distributed form. Only a few specimens have been collected, although numerous specimens have been observed. It is not improbable that more than one species occurs.

Family SCINCIDÆ

Mabuya multicarinata (Gray).

This species is a very common ground lizard. It occurs up to an elevation of at least 1200 meters. It may be distinguished from the following species of *Mabuya* by its brilliant iridescent coloring and by the yellow or cream stripe on the side of head and body.

Mabuya multifasciata (Kuhl).

This species is common only at low elevations. I have not collected it above 300 meters. It rarely if ever climbs trees. Many specimens taken.

Sphenomorphus jagori jagori (Peters).

Species of this genus differ from *Mabuya* in the absence of keels on the scales. The typical form of this species is found on the mountain usually along the streams or under logs in the forest. It occurs up to an elevation of 1000 meters. It is very much larger than the two following species of the genus. It is not improbable that two forms of this species occur on the mountain. Many specimens taken.

Sphenomorphus curtirostris Taylor.

This small species is not rare on the lower third of the mountain. I have collected it most frequently along mountain streams. The specimens rarely exceed a length of 110 millimeters. There are usually two dark stripes present along the sides. Many specimens collected.

Sphenomorphus steerei Stejneger.

This diminutive form is common at low elevations. It is found in the forest under leaves and along the streams. I collected a large series of specimens in a dry gully near Camp Eldridge during April and May. This species rarely exceeds a length of 70 millimeters.

Otosaurus cumingi Gray.

This is the largest skink found in the Philippines. It resembles *Sphenomorphus jagori* but the lateral stripe is broken into large spots. It runs through the forest making much noise and very rarely ascends trees. It appears to live in burrows. I have collected one specimen along the trail above the Forest School and have observed others near Los Baños.

Dasia smaragdinum (Lesson).

This species is common in coconut trees in the lowlands about the base of mountain and in forest low on the mountain. Its green color and slow deliberate movements on tree trunks makes it conspicuous. It attains a length of 200 millimeters. Many specimens collected.

Leiolepisma pulchellum (Gray).

This diminutive tree skink is not rare in low forest. The brilliant golden or cream line along the middle of the back makes it rather conspicuous in spite of its small size. It is usually found moving about on the trunks of large trees within two or three meters of the ground. Many specimens collected.

Tropidophorus grayi Günther.

This large skink, having extremely rough spiny scales over the entire dorsal surface, is common along the streams. It is usually found under partly submerged rocks or logs. Specimens are usually dull, dirty brown. The young have dull light bars on the back. Many specimens taken.

Brachymeles boulengeri Taylor.

This species is found usually in the forest under rotting logs or trash collected about the base of trees. It is a burrowing form. The shiny, smooth scales, and the short limbs make the species easily recognized. Several specimens taken.

Brachymeles bonitæ Duméril and Bibron.

A single specimen of this species was taken under a rock near the waterfall above Los Baños. It is a rare, burrowing species, without digits on the very diminutive limbs.

SNAKES

Key to snakes known from Mount Makiling

a[1] Teeth in upper jaw only. Small worm-like burrowing snakes with eye concealed under a scale (Family TYPHLOPIDÆ).

b[1] Dimunitive form, uniform gray or brown. Length about 185 mm. (Smallest species)—TYPHLOPS BRAMINUS (Daudin.)

b[2] Larger form reaching a length of 250 mm.

c[1] Nasal scale completely divided—TYPHLOPS LUZONENSIS Taylor.

c[2] Nasal scale not completely divided; black above reddish below—TYPHLOPS RUBER Boettger.

a[2] Teeth in both jaws.

b[1] Vestiges of hind limbs, very large snakes reaching a length of 9 meters (Family BOIDÆ)—PYTHON RETICULATUS (Schneider)

b[2] No vestiges of hind limbs (Family NATRICIDÆ).

c[1] Head covered with numerous small scales; no widened scales on belly; aquatic—CHERSYDRUS GRANULATUS (Schneider).

c[2] Head covered with large regular plates. Ventral scales on belly widened.

d[1] No fangs or enlarged grooved teeth in upper jaws. Non-poisonous.

e[1] Scales in 25 rows. Large, green or bluish green snake reaching a length of two meters—GONYOSOMA OXYCEPHALUM (Boie).

e[2] Scales in 21 rows. Large brownish snake reaching a length of one and one-fourth meters—ELAPHE ERYTHRURA (Duméril and Bibron).

e[3] Scales in 19 rows.

f[1] Scales keeled; belly with numerous irregular rows of black dots—NATRIX SPILOGASTER (Boie).

f[2] Scales keeled; belly with a single row of black dots on outer edges of ventral scales—NATRIX BARBOURI Taylor.

e[4] Scales in 17 rows.

f[1] Slender, elongate snake with upper surface transversed by about 80 dark bands—HAPLONODON PHILIPPINENSIS Griffin.

f[2] Short snake, rather dull brown in color; belly with numerous black triangular spots—CYCLOCORUS LINEATUS (Reinharat).

f[3] Short, moderately stout snake, usually lavender or brownish purple with a light reticulation, and a more or less definite neck band—LYCODON AULICUS (Linnæus).

f[4] A short, stout species, the body traversed by eighten to twenty dark purplish spots usually edged with black; belly usually pinkish—HOLARCHUS ANCORUS (Girard).

f[5] A short, slender, reddish-brown species with a few small, scattered, black spots on the anterior fourth of body; belly pink to orange—HOLOGHERRUM PHILIPPINUM Günther.

e[5] Scales in 16 rows. A large snake reaching a length of about one and one half meters. (The only Luzon species having an even number of scale rows)—ZAOCYS LUZONENSIS Günther.

e[6] Scales in 15 rows.

f[1] A slender greenish snake, the skin between the scales blue; arboreal; median scale row enlarged—DENDROPHIS PICTUS (Gmelin).

f[2] A small snake with a series of large whitish bands disappearing in adult.—OXYRHABDIUM SP.

e[7] Scales in 13 rows.

f[1] An arboreal snake, the median scale row not enlarged; greenish with distinct longitudinal black lines on the posterior part of the body—DENDRELAPHIS TERRIFICUS (Peters).

f[2] A very small, burrowing species reaching a length of about 265 mm.—CALAMARIA GERVAISII Duméril and Bibron.

d[2] No fangs, but enlarged grooved teeth present in the posterior part of maxilla; slightly poisonous but not dangerous.

e[1] Scales in 15 rows.

f[1] A very slender, grayish snake peppered over with minute black dots; arboreal—DRYOPHIOPS PHILIPPINA Boulenger.

f[2] Slender green snake with a white line on each side of the belly. Head very long (*Dahon palay*)—DRYOPHIS PREOCULARIS Taylor.

f[3] Long slender gray or buff colored snake very smilar to preceding species—DRYOPHIS GRISEUS Taylor.

e[2] Scales in 17 rows.

f[1] Slender elongated tree snakes, with a row of reddish flower-shaped spots along the middle of back; apical pits present in each dorsal scale—CRYSOPELEA ORNATA (Shaw).

f[2] Short, gray, mottled species, semi-arboreal—PSAMMODYNASTES PULVERULENTUS (Boie).

f^3 Scales in 19-25 rows.

g^1 Scales in 19 rows; black, with 80-90 cream or white rings—BOIGA DENDROPHILA DIVERGENS Taylor.

g^2 Scales in 21 rows; yellow-brown with indefinite dark blotches; a long, extremely slender snake —BOIGA ANGULATA (Peters).

g^3 Scales in 25 rows. A large form usually with a series of large brown blotches on the upper part of the body; buff forms without spots are sometimes found—BOIGA CYNODON (Boie)

d^3 Enlarged fangs in the anterior part of maxilla. Deadly poisonous. (Family ELAPIDÆ).

e^1 Scales in 15 rows. Large snakes reaching a length of four meters (king cobra)—NAJA HANNAH (Cantor).

e^2 Scales in 21 rows. Reaching a length of a little more than one meter—NAJA NAJA PHILIPPINENSIS Taylor.

c^3 Head large, triangular, covered with numerous small scales (Family CROTALIDÆ). Large fangs present. Tail short. Usually green with or without brown spots—TRIMERESURUS FLAVOMACULATUS (Gray).

Family TYPHLOPIDÆ

Typhlops braminus (Daudin).

This small burrowing snake is found in the lowlands, usually in the earth or under logs. It rarely attains a length of more than 150 mm. It is usually known as *odto-odto* or by some variant. A few specimens collected.

Typhlops luzonensis Taylor.

A single specimen, the type, was collected on the mountain above the Forest School.

Typhlops ruber Boettger.

One specimen of this rare species was collected at an elevation 600 meters under a small decaying log. The species is usually bronzy-black above and reddish brown on sides and belly. The tail is broader than long and is of greater diameter than the head.

Family BOIDÆ

Python reticulatus (Schneider).

I have collected no specimens. There are, however, specimens present in the College of Agriculture collection and in that of the Forest School. This species is usually known as *sawa*. It attains a length of about thirty feet.

Family NATRICIDÆ

Chersydrus granulatus (Schneider).

This species is confined to Laguna de Bay and small streams which empty into it. An aquatic snake distinguished by the absence of broad ventral scales. Adults are dirty lead color, sometimes showing dull white spots.

Natrix spilogaster (Boie).

This species is found in the lowlands; it probably does not extend up to any considerable elevation on the mountain. It is a common snake usually known as *ahas palaking*. Several specimens taken.

Natrix barbouri Taylor.

A single young specimen which I have identified as belonging to this species is in the collection of the College of Agriculture. It may be distinguished from the preceding species by its having a single row of dots on the outer part of the ventral scales instead of several irregular rows. Probably very rare.

Cyclocorus lineatus (Reinhardt).

A short dark snake with triangular black spots on the belly. It is usually found under logs or under leaves in the forest. It is a ground species, never entering the trees. A few specimens taken.

Oxyrhabdium leporinum (Günther).

Two specimens of this rare species have been found. The young are dark and have white bands; the adults are a dull uniform blue. Medium sized specimens show traces of the light bands. One specimen was taken at an elevation of 780 meters.

Haplonodon philippinensis Griffin.

A single specimen of this rare species was taken on the mountain. It is an arboreal species with a large number of irregular brown spots separated by narrow, lighter interspaces.

Lycodon aulicus (Linnæus).

Several specimens have been collected on the grounds of the Agriculture College. It is often found in houses. It is commonly known as *ahas tolog*. It is not rare. In my work on Philippine snakes it is referred to the genus *Ophites*.

Holarchus ancorus (Girard).

There are specimens of this ground species in the collection of the College of Agriculture taken, presumably, at low elevation. The species is usually of lavender color with dark purple, or black spots on the back. There is an anchor-shaped mark on the head.

Dendrophis pictus (Gmelin).

This slender, green, arboreal species is common at low elevations. It may be easily distinguished from the following species by the absence of dorsal and lateral stripes on body and tail and fifteen instead of thirteen scale rows around the body.

Dendrelaphis terrificus (Peters).

This arboreal species has been collected along the small gully back of Camp Eldridge. There are also specimens in the College of Agriculture collection. The species resembles the preceding species, but it has several stripes which are absent in *Dendrophis pictus*. A few specimens taken. Not rare.

Gonyosoma oxycephalum (Boie).

This large, green, arboreal species reaches a length of two meters. Several specimens are in the collections of the Forest School and College of Agriculture. Four specimens are in my collection. It probably occurs up to the summit of Mount Makiling.

Elaphe erythrura (Duméril and Bibron).

This species is common in the lowlands. It is a terrestrial form and it is frequently confused with the cobras. It is of drab-brown or reddish-brown color. It is entirely harmless, and feeds on small mammals. Several specimens collected.

Zaocys luzonensis Günther.

A single adult specimen of this large species was collected during 1921 by a student of the Forest School. This species is extremely rare, only about half a dozen specimens being known. It differs from *Elaphe erythrura* in having the posterior fourth of the body and tail blackish in color, or blackish, with small yellow-brown spots on most of the caudal scales.

Calamaria gervaisii Duméril and Bibron.

Several specimens of this small burrowing form have been collected at the College. It is sometimes called *ahas-na-cuyog*.

Hologherrum philippinum Günther.

I collected a specimen of this rare species on the mountain above Los Baños. It was found curled under a log in a moist place. It is reddish to reddish brown above, with a few scattered spots on the anterior part of the body. The belly is usually a bright orange. A terrestrial form.

Dryophiops philippina Boulenger.

Several specimens of this slender, inconspicuous snake have been collected. It is strictly arboreal in habit. The color is drab to gray with numerous minute black dots usually present on the dorsal surface. Not rare.

Crysopelea ornata (Shaw).

Several specimens of this arboreal snake have been collected. There is usually a series of flower-shaped red spots present on the median line of the body by which it may be easily distinguished.

Dryophis præocularis Taylor.

This slender green snake known as the *dahon palay* is not uncommon. It is not deadly poisonous as is commonly supposed, although some poison is probably present.

Dryophis griseus Taylor.

This gray species is similar to the former species but appears to be specifically distinct. It is an arboreal form. One specimen taken.

Psammodynastes pulverulentus (Boie).

A single specimen of this species has been collected on Mount Makiling. The color varies from gray to brown with indistinct markings. It is probably rare on the mountain. It is a small semi-arboreal form.

Boiga dendrophila divergens Taylor.

One specimen was collected in the forest near the Forest School nursery. It is a tree or bush species apparently rare on the mountain. The color is black or grayish black with very numerous yellow bands.

Boiga angulata Peters.

A long, slender, arboreal snake, mottled grayish in color. A single specimen taken.

Boiga cynodon (Boie).

Two young specimens were presented to me by Mr. Otto Pflueger, In-charge of the Forest School. They were collected on the mountain sides, but the elevation at which they were found was not recorded. The species is a large arboreal form reaching a length of two meters. Probably rare.

Family ELAPIDÆ

Naja naja philippinensis Taylor.

There are specimens of this cobra in the collection of both the Forest School and the College of Agriculture. I have not collected it. The species attains a length of about one to one and one-half meters. It is deadly poisonous. Not rare.

Naja hannah (Cantor).

A number of specimens of the king cobra has been collected in or near the campus of the College of Agriculture and the Forest School nursery. The species reaches a length of more than four meters. It may be distinguished by the presence of two large post-parietal scales, which are absent or very small in *Naja naja philippinensis*. Deadly poisonous.

Hemibungarus calligaster (Wiegmann).

This small species is conspicuous by the red (or yellow) and black markings on the belly. It is a burrowing form. Its bite is poisonous, not improbably resulting in the death of the individual bitten. Many specimens have been collected on the Agricultural College farm. Young and adult vary greatly in color.

Family CROTALIDÆ

Trimeresurus flavomaculatus (Gray).

This green viper probably never attains a length of more than one meter. Its bite is poisonous usually resulting in death. Some specimens have a row of irregular brown spots along the back. The large head, covered with very numerous small scales, distinguishes this species.

ADDENDUM

Since this paper has gone to press I have obtained a few species not included on this list. The lot includes three unidentified frogs belonging to the genera *Rana*, *Polypedates* and *Cornufer;* one lizard *Gonyocephalus bitorques*, Peters.

ANÆSTHESIA IN PLANTS[1]

By D. A. Herbert

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Anaesthetics are defined as those substances which act on living cells in such a way as to abolish temporarily those activities which we regard as manifestations of life (1). The effect of chloroform, ether, and other anæsthetics on plants at first sight appears analogous with that produced in animal tissues, and on this account the term anæsthetization is a term commonly used in descriptions of effects of these substances on vegetable life. In the following experiments, however, proof is advanced of the absence of such an action, and the effects are shown to be produced by one of two causes,—either shock stimulus or injury stimulus.

Mimosa pudica was the plant chosen for the experiments as it shows response to stimuli with extreme rapidity and also to a greater degree than any other plant. Its common occurrence as a weed was an advantage, as hundreds of plants were available for the experiments. A great deal of work on this plant has already been performed, but owing to the fact that no quantitative examinations on the effect of stimulus have been published, it was found necessary to study in detail the effects of various stimuli before proceeding with the study of effects of anaesthetics.

Haberlandt (2) has shown that transmission of stimulus takes place through tubular cells in the phloem, which possess fine pores in their walls. Removal of the cortical tissue by Dutrochet, an early worker, showed that the remaining part was still capable of transmitting, but this was shown by Haberlandt to be due to the incomplete removal of the phloem; some of the tubular conducting cells still remained intact. This removal of all the tissue external to the wood is a difficult matter owing to the structure of the vascular bundle in traverse section, and unless a good deal of the wood is removed at the same time it can not be assumed with certainty that all the tubular cells have been removed. Haberlandt's theory has been questioned by Jost (3) and in order to test its truth a number of experiments were performed and repeated again and again so that possibility of accidental inaccuracies was reduced to a minimum. In most cases about twenty-five plants were used for each experiment.

When a stem or a petiole is cut a drop of liquid appears almost immediately on both surfaces. In the case of the petiole this occurs to the same extent whether the leaf is erect or relaxed, and its appearance is too rapid to show from which region exudation has taken place. If this first drop is removed quickly, however, the next forms only slowly and with a hand lens it can be seen that the liquid emerges from the cells in the phloem region. This liquid contains a large amount of non-crystalline solid in solution and if the drop is allowed to remain on the end of the cut stem or petiole it evaporates and forms a fairly effective plug which prevents further bleeding. The turgidity in these cells must be a necessary condition for the transmission of stimulus. An increase of pressure at one end of

[1] Experiment Station Contribution No. 102.

such a system (for example, at the primary articualtion) must be transferred to the other (following the same example, the secondary articulation). If the tubular cells have their turgidity destroyed by "ringing" the petiole with a sharp razor well into the xylem so that they are all cut, no transmission takes place when either end of the petiole is stimulated. Owing to the poor transmission in the stem when proper precautions are observed, all the following experiments were carried out on the petiole, which is much more suitable because it shows response more markedly.

The decortication method of Dutrochet was tried, but to ensure the complete removal of all tubular cells the petiole had to be whittled until a large amount of the xylem also had been removed. It was found that if the removal of these tubular cells was complete there was no transmission at all. The same result was found when they were all cut by ringing the petiole with a razor. Leaflets might be scorched or cut, and yet the primary pulvinus did not fall; conversely the primary pulvinus might be stimulated. The absence of transmission in the xylem would not be proved by experiments where the petiole was dexylified, because it would only prove whether or not the tissues external to it were active in this respect, and not that the wood was inactive. Dexylification is a much more certain operation than removal of the tubular cells. In petioles so treated it was shown that the rate of transmission was practically as rapid as in a normal leaf. It may be noted here that the removal of the wood in the petiole of the sensitive plant causes a permanent closing of the leaf in a short time, and in order to avoid this and bring about the erection of the leaf after the excitatory fall during the operation, the cavity where the wood had been was kept filled with water. This method was very effective.

More simple than this method of removal of tissue is the method of cutting it through with a sharp razor. Mention has already been made to the effect of cutting through the tubular cells, and to the fact that if a few are left uninjured transmission still takes place. If the petiole, therefore, is cut through just far enough to cut all the wood, a few tubular vessels will remain on the uncut side. Such a petiole was found capable of practically normal transmission. A somewhat deeper cut will sever all the tubular cells while leaving part of the cortex still intact. In this case it was found that there was absolutely no transmission. In a number of cases where transmission did occur after the operation, a section of the petiole showed that the cut had not been made deep enough, so that this was not conflicting evidence. It is evident that such an operation cannot be reduced to a state of microscopic accuracy, but sections can be made after the transmission test has been performed, and the actual extent of the cut determined.

These facts, therefore, support Haberlandt's theory of transmission. In some of the experiments described below it was necessary to clamp the petiole of the leaf firmly; in these cases, bearing in mind the means of transmission, it was necessary, therefore, to guard against producing a ligature effect.

A considerable amount of data on the response of *Mimosa* to various stimuli has been collected by Bose (4), and he has put the wrong interpretation on a number of the experiments, and in others dealt only with the more obvious appearances and jumped at conclusions. In the experiments to be described the following stimuli were studied: mechanical shock, wounding, heat, and various gases (including anæsthetics).

MECHANICAL SHOCK

The effect of a mechanical shock varies with its intensity. If the terminal leaflets are struck they close, and if shock is sufficient the primary pulvinus, as well as the secondary and tertiary ones are stimulated and the whole leaf assumes the sleep position. The mechanism of this is sufficient to show that here we are *not dealing with a case of transmission of stimulus.* In the experiments to be described below the normal course in undoubted cases of transmission of stimulus the leaflets close first on the pinna affected, and then the other pinnae droop and their leaflets close; finally the primary pulvinus is affected and the petiole then droops. The action in the case of a struck leaf is not transmission of stimulus but is due to the fact that the stimulus is spread over the whole of the parts affected; in this case the petiole is shaken. When the petiole is so fixed that the pinnae can be struck without the petiole being shaken no movement occurs in the primary pulvinus. Similarly when the primary pulvinus is struck the rest of the leaf is unaffected. In the same way if the middle of one of the pinnae is fastened firmly, the rest of the leaf may be struck violently without transmission whatever to the part beyond the clamp; and *vice versa.*

WOUNDING

The only precaution to be observed on the study of wound stimulus is the avoiding of shaking of the leaf or the stem. This may be avoided with certainty by clamping the parts firmly, but at the same time not tightly enough to produce a ligature effect. When the wound is made by cutting or pricking, an exitatory fall takes place in the leaf, and the stimulus is transmitted beyond the clamp. If the stem is operated on, the neighboring leaves are affected; generally the lower one falls first, then the upper, and sometimes others further along the stem or the petiole, also respond. If, however, a ligature is made round the stem or the petiole, as the case may be, the stimulus is not transmitted beyond it.

The rate of recovery after wound stimulus is much slower than that of a leaf which has fallen from mechanical shock, as the following table shows:

TABLE 1.—*Time of complete recovery in minutes*

Wounded	17	21	17	29	20	19	20	20	21	20
Struck	10	10	11	8	8	10	11	12	11	10

The time of recovery of leaves indirectly affected by the wounding, i.e. the leaf above or below which showed an excitatory fall, was the same as that of which had been mechanically stimulated.

TABLE 2.—*Time of complete recovery in minutes*

Struck	10	9	9	11	9	9	10	9	11	9
Indirectly affected by wounding	9	10	10	9	9	11	10	8	9	9

These readings are typical of some fifty that were made. Obviously the effect of a wound is much more profound than that produced by a blow. The pressure in the tubular cells has been reduced, so this is to be expected.

With regard to the intensity of the stimulus it may be remarked that the more violent the wounding, the more rapid the transmission. Mere cutting of the terminal leaflets may, for instance, result in a closing of the leaflets in one minute followed by the fall of the petiole a fraction of a minute later. Cutting of a pinna, however, results in an extremely rapid fall of the main pulvinus and an actual relative delay in the fall of all the pinnae. Some of the figures observed are as follows:

TABLE 3.—*Rate of response and recovery of injured leaves.*

	Time of fall of all the pinnae.	Time of fall of primary pulvinus.	Time of complete opening of all the leaflets.	Time of complete erection of primary pulvinus.
Leaflets only cut.....	60 seconds	94 seconds	600 seconds	360 seconds
	60 "	94 "	600 "	360 "
	60 "	80 "	420 "	880 "
Pinna cut.....	1 second	8 seconds	420 seconds	300 seconds
	1 "	10 "	360 "	300 "
	2 seconds	10 "	420 "	300 "
	2 "	1 "	780 "	660 "
	2 "	1 "	840 "	720 "
	3 "	4 "	420 "	300 "
	3 "	1 "	360 "	300 "
	3 "	1 "	360 "	300 "
	4 "	3 "	542 "	421 "
	4 "	2 "	400 "	303 "
	5 "	3 "	480 "	421 "

These readings were all taken at the same time on the same day so that the plants would be under similar atmospheric conditions. In the case of more violent wounding the stimulus is transmitted down the petiole to the primary pulvinus before the other pinnae are affected. It appears as if when such a stimulus is transferred it has not time to sidetrack to any great extent into the other pinnae before it has reached the primary pulvinus. If however it is weaker it passes into the pinnae along the side branches of the transmission channels as rapidly as it does down the direct route of the petiole.

HEAT

The effects of heat on *Mimosa pudica* come under two headings, first, heat shock, and second, heat injury.

If the heat is applied gently so that the leaves are not scorched, an excitatory fall is produced, resembling in all respects that produced by mechanical shock. The temperature itself is not the only deciding factor, but the action is also influenced by the atmospheric conditions and the rate at which the heat is applied. If the heating is done by means of a lens the fall is restricted to the leaf heated, but if a candle is used a fall is frequently produced in neighboring leaves. This is due not to transmission, but to the radiation of the heat to the others, in the same way that the fall of a number of leaves when one is struck is due to the shaking being spread over a larger space than that occupied by the single leaf.

If, however, the heat is sufficient to cause actual injury to the leaflets being stimulated, then the results are comparable with those produced by wounding. The temperature which will cause injury varies with individual plants but in normal cases varies between 60° and 70 C.

GASES (INCLUDING ANÆSTHETICS)

Bose has studied the effects of various gases on the irritability of *Mimosa pudica*, using for the purpose his Resonant Recorder, but has not considered it from a quantitative point of view, and further adopts the generally-held view that the action is narcotic in some cases. Quantitative experiments are extremely difficult, but even the degree of accuracy which can be attained is sufficient to show that the action is not narcotic. Chloroform, ether, and ammonia are the gases said to act in this way; three others, hydrogen sulphide, nitrogen dioxide, and sulphur dioxide, which are regarded as undoubted poisons, were also studied.

Chloroform.—Everything depends on the amount of stimulation of the leaf. Chloroform gas blown on to the leaf causes a fall of the same type as produced by mechanical shock. In Bose's experiments the gas was introduced into a chamber in which the *Mimosa* plant was confined. Under such conditions the effect is continuous, and there is great danger of injury being produced by the prolonged exposure. If, however, the gas is very dilute recovery takes place even in its presence, thus showing that the initial response was due to the effect of shock. Prolonged exposure to the dilute vapour of chloroform or the spraying of the leaves with chloroform with an atomizer gives the same result,—a fall comparable to that produced by a wound. There is no transmission when the amount of chloroform used is sufficiently small to produce no injury to the tissues. It is necessary to provide the treated portion of the leaf with a shield which will prevent diffusion of the gas to other parts of the plant. When this precaution is observed there is not only no transmission to other leaves, but none to the part of the treated leaf beyond the shield. As soon as injury is produced, however, the rest of the leaf falls. The effect may be felt by the others above and below it on the stem.

The mechanism of the fall with excess of chloroform is similar to that produced by wounding. A relatively weak injury stimulus results in the fall of the pinnae before the primary pulvinus is affected and a stronger one in the fall of the primary pulvinus before the pinnae which have not been stimulated begin to close.

In the following table the chloroform was blown on to one pinna of each leaf in a fine spray and was almost immediately removed by evaporation so that the additive effect of continuous stimulus was eliminated.

An experiment as quantitative as possible was made by regulating the amount of chloroform sprayed on to a pinna, and the time of recovery noted. The whole of the amount sprayed does not of course reach the leaflets, some being lost through evaporation and some passing between them or past their edges. A control experiment where the leaves were treated with enough chloroform to cause a fall but no injury was also made, and a comparison of the results is shown in the following table. The times are in minutes and the figures in the horizontal columns are naturally not obtained from the same leaves.

TABLE 4.—*Rate of response of leaves treated with chloroform.*

	Time of closing of all the leaflets.	Time of fall of primary pulvinus.
Sprayed with a trace of chloroform	36 seconds	60 seconds
	27 "	30 "
	36 "	60 "
	36 "	60 "
	26 "	28 "
	26 "	28 "
Sprayed with enough chloroform to produce an injury stimulus	2 seconds	2 seconds
	3 "	2 "
	3 "	2 "
	3 "	1 "
	4 "	1 "
	8 "	5 "

TABLE 5.—*Rate of recovery of leaves treated with different amounts of chloroform.*

Control.	Amount of chloroform.				
	.3 c.c.	.6 c.c.	.9 c.c.	1.2 c.c.	1.5 c.c.
15 minutes	65 minutes	98 minutes	Recovery incomplete	No recovery	No recovery
15 "	65 "	98 "			
15 "	66 "	99 "			
16 "	66 "	99 "			
16 "	67 "	99 "			

The leaflets on the pinnae treated with .9 cc. only recovered to the extent of opening about half-way; this was accomplished in slightly less than two hours. From these figures it will be seen that the amount of response in *Mimosa pudica* stimulated with chloroform depends on the amount of stimulus and that the results may be compared to the cases of mechanical shock and wounding. Wounding bears the same relation to mechanical shock as injury by chloroform does to simple chloroform stimulation without actual injury.

The question to be decided is whether or not chloroform acts as an anaesthetic. Bose, who has added as much to the knowledge of the irritability of *Mimosa pudica*, does not agree with Haberlandt's theory of the hydromechanical transmission of impulse, and concludes that "transmission effect could only be due to propagation of excitatory protoplasmic change" (page 159). On this assumption he concludes that the action of chloroform is narcotic, and compares the transmission of stimulus through chloroformed tissue with transmission through the nerve in a frog's sartorius which has been rigored by dipping in warm oil. He quotes Biedermann as saying that the half which remained normal twitched on cutting the rigored portion with scissors, showing that excitable nerve fibres could still be mechanically excited between the rigored and the dead muscle fibres. This is paralleled with the transference of stimulus which takes place through a chloroformed or scalded leaf, the stimulus being conveyed just as well when the leaf is chloroformed or scalded as when it is in the normal condition.

It may be pointed out here that this transmission occurs in the same way when the leaf has fallen through mechanical shock, and so the properties of

a leaf as far as transmission is concerned are in no way different in the two cases. We must therefore either assume that all relaxation in *Mimosa* is narcotization whether caused by wounding, shock, mechanical stimulus, or stimulus by substances which are animal narcotics, or else we must assume that there is no narcotization at all.

The latter view is supported by the work of Brown (5) who confirmed Pfeffer's conclusion "that the movement of the living pulvini is due to changes in the osmotic pressure of the cells of the reacting half, and shown that movement in the pulvini can take place without the aid of any vital phenomena." The elimination of vital phenomena dismisses Bose's theory of transmission by propagation of excitatory protoplasmic change, and with it the possibility of narcotization.

The final proof of non-anaesthetization is shown by the fact that if *Mimosa pudica* plants be placed under a bell jar to which small amounts of chloroform gas are introduced an excitatory fall is produced. If the chloroform is left in contact with the leaves, they will recover in the same length of time which it would take a mechanically stimulated leaf to resume its normal position. If, however, the amount of gas be increased a prolonged fall is produced, and the plant does not recover till the chloroform is removed. Even then recovery is not complete; the difference is therefore due to the fact that injury stimulus has been produced. In the first type the fall has taken place because of the *sudden* change of conditions. If anaesthesia had taken place recovery would of course not be effected until the exciting agent had been removed.

Effects of other gases.—The effects of other gases, ammonia, hydrogen sulphide and sulphur dioxide are similar to those of chloroform but they differ in degree. Ether has very much the same effect, but the other three are more toxic, and cause death to the *Mimosa* leaves in much greater dilution than do chloroform and ether. If these gases are applied in sufficiently small amount to a pinna which is effectively screened from the other pinnae a fall similar in all respects to that produced by mechanical shock takes place and is not transmitted beyond the screen. In greater amounts the effect is similar to that produced by a mechanical injury and may be transmitted first to the primary pulvinus, then to the other pinnae and often to neighboring leaves.

The stimuli that produce an excitatory fall in Mimosa may, therefore, be classified into two types, first, simple response, and second, injury stimulus. The first is typified by the action of mechanical shock, where the stimulus is too feeble to produce appreciable transmission. A similar response is found where the leaves are subjected to a chemical stimulus regulated so that no injury is produced, and where leaves have been affected by transmission of a stronger stimulus though not directly stimulated. The second type is produced by injury which may take the form of cutting or of heating or of chemical stimuli.

Evidences against the narcotization of Mimosa by chloroform and ether are afforded from four points of view:

1. In small quantities they produced the first type,—simple response. In larger quantities they produce effects similar to those produced by undoubted plant poisons, such as hydrogen sulphide, sulphur dioxide and ammonia.

2. Transmission takes place through relaxed leaves subjected to a strong stimulus, whether the original stimulus was due to mechanical shock or the action of other "simple stimuli".

3. Transmission is not due to "propagation of excitatory protoplasmic change," so that narcotization can not take place.

4. Recovery takes place when the "anaesthetic" is in amounts small enough not to cause injury, even though the gas be still present.

Support to the theory that substances capable of causing anaesthesia in animal cells do not cause anaesthesia in plants, but rather effects similar to those produced by ordinary poisons is lent by the work of A. R. C. Haas (6) on *Laminaria*. He found that an anaesthetic, if used in "sufficient concentration," promotes an increase in respiration, his results therefore disproving the theory of Verworn that these substances produce a kind of asphyxia. *Mimosa pudica*, being a much more responsive plant than *Laminaria*, is a much better agent for the demonstration of the actual nature of "plant anaesthesia". The results of Haas lend support to the theory advanced above in that the increase in respiration is a phenomenon observed when plants are injured. Further, after the first increase, there is a marked decrease if the reagent is sufficiently toxic while if the amounts are smaller the decrease is much more gradual. These observations therefore fall into line with the theory advanced above.

SUMMARY

1. Experimental support is given to Haberlandt's theory of transmission in *Mimosa pudica*.

2. Stimuli may be divided into two types
   - *a*. Simple response produced by mechanical shock and properly controlled chemical stimuli, etc.
   - *b*. Injury due to mechanical, chemical and other agencies.

3. The first type is too feeble for rapid transmission, but the second is rapidly conducted.

4. Leaves indirectly affected by a transmitted stimulus behave like leaves which have shown simple response.

5. Rate of transmission and time of duration of the effects of the stimulus are directly proportional to the amount of stimulus.

6. Chloroform and ether do not narcotize Mimosa. Their effect is similar to that of more violent poisons such as ammonia, hydrogen sulphide, and sulphur dioxide, but differs in degree. Properly regulated amounts of these substances produce simple response, but in excess they produce an injury stimulus. Anaesthesia is not produced in plants by the use of gases which produce this phenomenon in animals.

7. In the presence of small amounts of these gases an excitatory fall is first produced, but the leaf re-erects itself and the time taken is the same as that in the case of simple stimulus. Where the effect is prolonged it is found that injury has been produced and complete recovery does not take place.

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THE TOXICITY OF IPIL-IPIL (*Leucæna glauca*)

By Valente Villegas

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Present day scientists are prone to indulge in ridicule whenever a layman or "old-timer" gives his view on questions requiring controlled means of observation. But Steenbock of the University of Wisconsin was farther visioned when he undertook work to verify the farmer's common saying that yellow corn has a better feeding value than white corn. The writer, having in mind the popular dictum of old horsemen that ipil-ipil or Sta. Elena (*Leucæna glauca*) is the cause of horses' hair falling out, conducted a trial with this end in view and thereby verified an old man's opinion.

About two months ago the case of a beautiful mare and foal came to my attention. This mare and foal were turned loose in a pasture of grass in which was a thick stand of ipil-ipil. These animals were then looking normal with long manes, tails and coats, but rather thin. After a certain length of time they were taken by the owner, and I then enquired into the bare condition of mane and tail. Without hesitation the owner remarked that it was the effect of ipil-ipil feeding. The coat of both animals was normal and both were improved in flesh. A little later two of the College fillies were brought in from a pasture of grass and ipil-ipil, in which they were being kept for sometime, and they had also lost a considerable amount of hair from their manes and tails. These animals were in good condition otherwise. Immediately the veterinary authorities were consulted and parasites were searched for on the mane and tail but only one or so could be located. One of the fillies was given treatment at the veterinary clinic and the other withheld to compare the behavior of the mane and tail on recovery. I already had the suspicion as to the ipil-ipil causing this malady and it so happened that the filly which was let alone grew hair faster and better than the one treated. If any parasites were present certainly the one treated should have shown more improvement than the other. This stimulated my interest into taking up the problem seriously from the standpoint of the belief in the causative action of the ipil-ipil.

On September 2, 1922, a colt was subjected to trial giving him only ipil-ipil in the form of leaves, seeds and tender stems. For about three days this colt would eat nothing but ipil-ipil but later refused to eat this readily and so was allowed to eat grass for roughage with ipil-ipil seeds mixed with rice bran as concentrate. On the sixth day the hair pulled off very readily, but in this case not only on the mane and tail, but also all over the body including the extremities. Before the trial the writer tries to pull off the hairs of mane and tail as well as of the body but to no avail. This wholesale shedding off of hair in this particular subject, the writer suggests, may be due to the fact that the animal has been more intensively fed or "drugged" on ipil-ipil.

To my mind this particular mode of behavior of ipil-ipil is interesting not only from the standpoint of its effect on horses but also from that on other

[1] Experiment Station Contribution No. 101

classes of livestock which may likewise be affected. It would also be interesting to find out any effect this feed has on other functional activities of the animal body. Finally in the event of the isolation of the causative principle in question the ipil-ipil may become a commercial source for the concoction of certain preparations in pharmacology.

The writer has plans to carry out further more elaborate research into the effect of the pilipil on the hair of horses and it is hoped that other classes of livestock will also be experimented with later on. The feeding of the different parts of the plant to horses to determine the presence and relative amount of the principle in each part would next be in order. Later the Departments of Chemistry and Animal Husbandry may cooperate in ascertaining the actual chemical constituent responsible.

PARASITOLOGICAL STUDIES BY THE USE OF COLLODION SACS IMPLANTED INTRAPERITONEALLY.[1]

I. Notes on the Life-History of *Ascaris lumbricoides*.

By Marcos A. Tubangui, Gregorio San Agustin, and Francisco M. Fronda

Collodion sacs implanted intraperitoneally have afforded a means of cultivating bacteria under conditions approaching the invasion of a host. Due to the semipermeable character of the sacs, the bacteria are in a place where they are able to derive nutritive substances from the peritoneal fluid and at the same time to yield soluble diffusible products which might affect the animal. In the Institute Pasteur, France, this method of investigation enabled Metchnikoff, Roux, and Taurelli-Salimbeni (1) to demonstrate the liberation of a soluble diffusible toxin by the cholera vibrio.

It occurred to us that collodion sacs may serve a useful purpose in parasitological studies. It was believed that their application, if successful, would be of value in the explanation of certain phenomena occurring during the development of certain animal parasites and may also be of aid in the determination of their pathogenicity.

PREPARATION OF COLLODION SACS.

Gates (2) described a method for preparing collodion sacs for use in bacteriology. At first we followed his tecnique, but we decided later that, inasmuch as our purpose does not require strict asepsis as must be observed in bacteriological studies, we could utilize a simpler method. Consequently we prepared our collodion sacs in the following manner, modifying the combinations of Looney (3) in order to obtain as much flexibility and semipermeability as possible and at the same time produce strong sacs.

> 8 gms. of Du Pont's "Parlodion" dried for 24 hours over concentrated sulfuric acid are placed in a clean, dry, amber-colored bottle. 15 cc. of absolute ethyl alcohol, 50 cc. of ether, and 5 cc. of ethyl acetate are added and after vigorous shaking the bottle is allowed to stand. It requires two or more days to completely dissolve the collodion and it is necessary to shake the bottle every now and then. The thick supernatant fluid is then decanted off into another colored bottle and is ready to be used.
>
> A small, perfectly clean and dry test-tube is filled with the collodion solution, which, after a few seconds, is poured back into the container by holding the test-tube at an angle of about 60° and slowly rotating it until the collodion no longer drips freely. The test-tube is now placed between the palms of both hands and rolled moderately fast in an inverted position until the collodion is apparently dry and is then clamped upside down to a stand. When the membrane, which is that portion of the collodion so-

[1] Experiment Station Contribution No. 103.

lution which was left adhering to the wall of the test-tube, is completely dry, it is removed by peeling the top from the mouth of the test-tube and then pouring some water between the membrane and the side of the test-tube.

Depending upon the size of the sac desired to be implanted, a certain length of the portion towards the open end of a sac thus prepared is cut off with scissors. After introducing into the remaining portion whatever is to be placed, the open end of the sac is closed by first tying with silk thread and then sealing the stump with collodion solution.

We have usually used sacs about 2.5 cm. by 1 cm. in size. They are introduced into the peritoneal cavities of mammals by making brave incisions on the side of the abdomen while the animal is under complete ether anaesthesia. Two layers of sutures are then placed and the wound is painted with flexible collodion. In the case of chickens the intraperitoneal implantation of collodion sacs is easily accomplished by simply making an incision through the last intervertebral space as is practiced in caponization. We have usually implanted one or two sacs without detecting any uneasiness from our experiment animals.

We have chosen to work first with the eggs of *Ascaris lumbricoides* because of the ease with which they can be cultured and because of their resistance to various chemicals which kill most helminth eggs. Whenever it was desired to free the eggs from contaminating bacteria after they are placed in collodion sacs, we immersed the latter in 1.5% nitric acid solution for 5 or 6 days, which was sufficient in most cases to destroy all forms of microorganisms. The acid was subsequently removed by dializing the contents of the sacs against sterilized tap water several times until the dializate, when tested with litmus paper, was neutral or slightly acid in reaction.

We used in all these experiments eggs obtained from a single female specimen of *Ascaris lumbricoides*. The eggs were cultured and kept in shallow Petri dishes with 2% formalin solution at room temperature.

RESULTS OF EXPERIMENTS

Without going into details on the complete history of the animals used in these experiments, the results which are discussed in this paper may be given as follows:

1. Embryonated eggs of *Ascaris lumbricoides* in semipermeable collodion sacs hatched as early as 20 hours after implantation in the peritoneal cavities of guinea pigs.

Sacs containing eggs contaminated with bacteria contained partially disintegrated larvae, or no larva at all but many empty egg-shells after 6 or more days.

Sacs containing eggs freed from bacteria contained free, active larvae after 3 to 27 days.

2. Impermeable collodion sacs containing *Ascaris* eggs contained very few if any hatched larvae 2 to 4 days after implantation in the peritoneal cavities of guinea pigs.

3. Embryonated *Ascaris* eggs in semipermeable collodion sacs implanted intraperitoneally in dogs and cats hatched in from 1 to 2 days.

4. Semipermeable collodion sacs containing *Ascaris* eggs contained hatched larvae 20 hours after implantation in the peritoneal cavities of chickens. The liberated larvae, however, were dead while the embryos with their shells intact were still alive, showing that the newly hatched larva is more easily killed by higher temperatures. All the unhatched eggs in sacs recovered 2 to 4 days after implantation contained dead, vacuolated embryos.

DISCUSSION

HATCHING OF *ASCARIS* EGGS

The conditions which determine the hatching of *Ascaris* eggs have not been satisfactorily explained. That hatching is not due to an enzymatic action which destroys the coverings of the eggs, is further proved in the present experiments because of the fact that enzymes, if any be present in the peritoneal fluid, being colloidal in nature, cannot reach the eggs through the collodion sacs.

Martin (4) has concluded that three factors are necessary for the liberation of the embryo, viz., (*a*) the complete development of the embryo, (*b*) a surrounding medium that is alkaline or neutral in reaction and (*c*) a temperature that is the same as the temperature of the host of the parasite. According to this author *Ascaris* eggs do not usually hatch in the stomach because of the acid reaction of the contents of this organ. Ransom and Foster (5), however, have found these factors insufficient to account for the hatching of *Ascaris* eggs. Davaine (6), Schwartz (7) and others are of the opinion that hatching takes place as a result of the rupture of the egg-shell due to the increased activity of the enclosed embryo when subjected under the influence of the body temperature of the host.

Our object in implanting collodion sacs filled with embryonated *Ascaris* eggs in the peritoneal cavities of different animals was partly to seek for a possible explanation of the hatching of these eggs. Our results show that they hatched in guinea pigs, dogs, cats and chickens, but only with difficulty in the latter animals. The peritoneal fluids of these animals, as well as the contents of the collodion sacs, when tested, were alkaline in reaction. Their rectal temperatures during the periods of our observations were as follows: guinea pigs, 37.8° to 38.0° C.; dogs, 38.5° to 38.9° C.; cats, 37.7° to 39.5° C.; chickens, 41.8° to 42.3° C.

It would appear, as claimed by Davaine, Martin, and Schwartz, that the body temperature of the host influences to a very important extent the liberation of the embryo. Even in chickens in which hatching was least expected to occur, a small number of embryos were liberated, due apparently to the stimulating effect of the body temperature. In order to test these opinions further and to inquire why hatching seldom takes place *in vitro* even at the temperature of the body, we implanted very thick impermeable collodion sacs containing embryonated *Ascaris* eggs in two guinea pigs. We found that hatching did not occur, at least not as readily as when semipermeable sacs were used. In one of these thick sacs we failed to notice even a single liberated larva and in the other we found only one free but dead larva and one dead embryo with one-half of its body extruding through an opening in the egg-shell.

These observations point to the fact that there are other conditions besides those mentioned by Martin which are responsible for the hatching of *Ascaris* eggs. We suspected that there must be something in the bodies of suitable

animals which aids in the escape of the embryo from its shell or that the embryo itself undergoes certain changes which enable it to break its shell. The second possibility occurred to us more plausible, so that we began to examine very closely newly-hatched larvae obtained from implanted collodion sacs and larvae which were artificially expelled from the eggs by applying pressure. Measurements of twenty-six newly-hatched larvae (1 to 3 days old) showed the following variations in size: 0.227 mm. to 0.257 mm. long by 0.010 mm. to 0.014 mm. thick. Thirty-seven artificially hatched larvae measured 0.215 to 0.249 mm. long by 0.010 to 0.012 mm. thick.

It is rather difficult to draw conclusions from the above figures, because they show very slight differences. Furthermore the variations in size of the newly hatched larvae may be originally due to variations in the size of the eggs; and since there is no way of determining which larvae came from smaller or larger eggs, a very accurate interpretation cannot be given. On the average, however, a newly hatched larva was found to be slightly larger or more active than an artificially expelled larva. Therefore, it may be presumed that when fully developed *Ascaris* eggs are introduced in the body of a suitable animal, the embryos may either undergo a certain amount of growth or become more vigorous and by their more active movements they are able to break the shells. This may be explained by the assumption that certain nutritive substances are able to penetrate the coverings of the eggs and thus reach the embryos. This is possible when eggs are placed in semipermeable collodion sacs; but when they are placed in impermeable sacs nutritive substances cannot diffuse into the eggs.

EFFECT OF BACTERIA ON ASCARIS LARVAE

In four controlled experiments in guinea pigs, it was found that collodion sacs filled with embryonated *Ascaris* eggs, which were freed from bacteria by immersion in 1.5% nitric acid solution for 5 to 6 days, contained free, active larvae when recovered 3 to 27 days after implantation. The contents of such sacs remained clear like water, while the contents of sacs which were not treated with nitric acid solution became pusy in appearance after 6 or more days. In only one instance (in a pup) did we succeed in finding a single free, active larva in a sac containing contaminated *Ascaris* eggs. In all others, we found hatched but partially disintegrated larvae or we found no larva at all but many empty egg-shells when examined 6 to 15 after implantation.

It is apparent from these findings that the newly hatched Ascaris larva is easily killed and disintegrated by bacterial organisms. It may be stated in this connection that Ransom and Cram (8) have observed that *Ascaris* larvae from the lungs 1 mm. or more in length show more resistance to the action of artificial gastric juice than smaller larvae up to 0.8 mm. in length. According to Miyagawa (9) *Ancylostoma* larvae are more resistant to the action of human gastric juice after passing through the lungs than before their passage through these organs. In the light of these observations it may, therefore, be said that *Ascaris* and *Ancylostoma* larvae are better able to withstand unfavorable surroundings as they become more advanced in age; and that the migrations of newly hatched *Ascaris* larvae to the lungs enable them to escape from the injurious effects of the bacteria and digestive fluids present in the intestines.

THE RELATION OF CHICKENS TO THE SPREAD OF *ASCARIS LUMBRICOIDES*

In certain places where chickens are allowed to run at large and where they sometimes gain access to human excrement, it is important to know if these animals, by ingesting the eggs of *Ascaris lumbricoides*, are able to spread the parasite. Ackert (10) has recently determined that hookworm eggs remain viable and hookworm larvae are apparently not injured while passing through the alimentary canal of chickens.

Although our experiments were performed in a different manner from those of Ackert, we believe that our results have a similar bearing in that, as far as we are able to determine at present, the principal factor to be considered is the relation of parasite eggs to the high temperature of chickens. We have found, as stated elsewhere, that a limited number of embryonated *Ascaris* eggs hatched in the peritoneal cavities of chickens, while those which failed to hatch still contained motile embryos 20 hours after implantation. We did not determine whether or not these eggs were still infectious but, judging from the fact that they continued to show motility on being stimulated several hours after they were removed from the chickens, it may be assumed that they would hatch when fed to suitable animals.[1]

In the settlement of this question it is also necessary to consider the length of time during which the eggs have to remain in the body after they are ingested by chickens. According to our observations *Ascaris* embryos are killed in two days when exposed to temperatures between 41.8° and 42.3° C. (body temperatures of chickens). If it takes this much time from the time they are picked up before the eggs are excreted, the danger of chickens spreading viable *Ascaris* eggs is remote. According to Ackert, however, it takes only from two hours and forty minutes to sixteen or more hours for food material to pass through the digestive tract of chickens, in which case there is danger of viable Ascaris eggs being spread by chickens.

SUMMARY

1. Embryonated *Ascaris lumbricoides* eggs in semipermeable collodion sacs hatched as early as 20 hours after implantation in the peritoneal cavities of guinea pigs, dogs, cats and chickens.

2. Temperature is an important factor in the liberation of the embryo. Temperatures between 37.8° and 42.3° C. allow hatching to take place. At 41.8° to 42.3° C., however, newly hatched *Ascaris* larvae do not live long.

3. The hatching of *Ascaris lumbricoides* eggs is due to an active penetration of the egg-shell by the embryo under the influence of the body temperature of the host. Before this can take place, however, it seems necessary that nutritive substances be available in the utilization of which the embryo may increase in size or at least become more active in its movements so as to be able to break its shell.

4. Newly hatched *Ascaris lumbricoides* larvae are very easily killed and disintegrated by bacteria. In the intestines of the host this bacterial action is incidentally avoided by the migrations of the larvae to the lungs.

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[1] We have also observed that *Ascaris eggs* in the early stages of segmentation, which were recovered from sacs implanted for 20 hours in chickens, continued to develop

5. Chickens are apparently able to spread *Ascaris lumbricoides* by ingesting the eggs.

ADDENDUM

After the manuscript of this paper was sent to the Press, we fed *Ascaris* eggs to two chickens in order to determine if there are conditions in the digestive tract which might prove injurious to these parasite eggs. Examination of the feces twenty hours after feeding showed that most of the embryos of fully developed eggs were free, but dead. Some of the eggs in the early stages of segmentation, when cultured in 2% formalin, failed to develop any further, while some showed the presence of motile embryos after 11 days. These findings are, therefore, in accord with the results described.

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A METHOD OF MULTIPLYING TWO NUMBERS THAT END IN 5.[1]

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METHOD

In the numbers 35, 75, 155, 295, let 3, 7, 15, and 29 be considered respectively as their *tenth* digits.

(1) See if the difference of the two tenth digits is even or odd. If even, the product ends in 25; if odd, the product ends in 75.

(2) Add 1 to the larger tenth digit; multiply this sum by the smaller tenth digit; then add half of the difference of the tenth digits to this product, discarding the half that may result if the difference is odd. The result will be the hundredth digit of the product.

EXAMPLES

1. 35 x 95 = ?

9—3 = 6, even number — product 25

3 x (9+1)+$\frac{6}{2}$ = 33 — 33

Therefore 35 x 95 = 3325

2. 45 x 115 = ?

11—4 = 7, odd number — product 75

4 x 12+3 = 51 — 51

Therefore 45 x 115 = 5175

With a little practice, two numbers ending in 5 may be readily multiplied mentally.

PROOF OF THE METHOD

Let the larger tenth digit be b; and the smaller one, s. Then the numbers are $(10b+5)$ and $(10s+5)$.

Multiplying we have

$(10b+5)\ (10s+5) = 100bs+50\ (b+s)+25 = P.$

But $50(b+s) = 100s+50(b-s)$

Therefore $P = 100bs+100s+50(b-s)+25,$

$100s(b+1)+50(b-s)+25.$

Now if $(b—s)$ is even, 50 $(b—s)$ will be equal to 50 x $2n$, where n is half of $(b—s)$, an integer. Hence 50 $(b—s) = 100n$ and n to be added to the hundredth digit of the product, which is $s\ (b+1)$. This makes the hundredth digit = $s\ (b+1)+n$ and the last two digits 25.

But if $(b—s)$ is odd then 50 $(b—s)$ will be equal to 50 x 2 m+50 or 100 m+50, where m is $\frac{b-s}{2}-\frac{1}{2}$.

Hence the hundredth digit is $s(b+1)+m$ and the last two digits will be 50+25 or 75.

[1] Experiment Station Contribution No. 104

In the examples above every step is written. But all of them may be easily performed mentally. Take as an example 65 x 145.

It is easy to see that the last two figures will be 25, and 6 x 15+4=94; the product is 9425.

$$\left.\begin{array}{l} 135 \times 295 = \ldots 25 \\ (13 \times 30 + 8 = 698) \end{array}\right\} = 69825;$$

$$\left.\begin{array}{l} 125 \times 495 = \ldots 75 \\ (12 \times 50 + 18 = 618) \end{array}\right\} = 61875.$$

The above method is of course only practicable when the numbers are small, or when the larger tenth digit is 1 less than a multiple of 10.

COLLEGE AND ALUMNI NOTES

Friends of Prof. Reinking, formerly a member of our faculty, will be pleased to learn that after qualifying for his doctorate in Wisconsin University he accepted a position with the United Fruit Company with far higher salary than he had received here. Dr. Reinking will be stationed at Tela, Honduras, and engaged almost exclusively in diseases of bananas. This means that we have lost another of our most effective men through inability to meet the rates of salary being paid in other parts of the world.

On November 9, 1922, the president of the Senior Class of the College of Agriculture received a telegram informing him of the arrival at Manila of Durian seedlings from Davao, Mindanao. The Class has adopted this particular plant as the tree to be planted during their Class Day celebration.

The Visayan Club held its inaugural dance at the Forest School on Saturday Nov. 4. The reception Committee consisted of Professors Roa, Pfluger, and Salvosa. Mr. Henaris and Dr. Manresa, and about a hundred were present.

Venerando Marilao, '22, is now working with the Maao Sugar Central Co. at Pulupandan, Negros Occidental, under the direction of the Bureau of Science.

On Nov. 3 the members of the Senior Class of the College of Agriculture went on a two days' excursion to the island of Talim, Rizal. Despite the bad weather the excursionists enjoyed their visit to the three barrios. They sailed back to Los Baños at noon on November 5, after spending 36 hours in the Island. Thanks are extended by the Class to Mr. Primo San José, a Talimian senior, who acted as leader, and to the people of Tana, Lambac, and Balibago for their hospitality and their courteous appreciation of the visit.

Ramon K. Habaluyas, '19, is engaged in farming in Nueva Ecija. He was here for a few days' visit during the last week of October.

Tomas D. Harder, '19, is in charge of LaPaz Demonstration Station of the Bureau of Agriculture at La Paz, Iloilo.

Antonio C. Sanchez, '22, is at present operating his own farm at Clarin, Bohol.

Francisco D. Marquez, formerly in charge of the La Carlota Experiment Station, has gone into farming. In a letter recently received he says he is planting coffee trees, has planted avocados and limas and intends to plant bananas

and coconuts soon. He has a few head of cattle including an Indian bull. He has applied for the commutation of his accrued leave and expects to use the proceeds for the extension of his farm located at Biao, Binalbagan, Occidental Negros.

Cenon R. Paulican, '17, is now managing Dagumban Cattle Ranch. His present address is Dagumban, Bukidnon.

Leopoldo G. Mendoza, '17, is in charge of a rice farm of over 300 hectares, owned by Mr. E. E. Schneider, his step father, in Mabatobato, Pili, Camarines Sur. Mr. Mendoza is using a Witchita tractor as an experiment in the introduction of modern machinery in rice fields. It may be of interest to the other alumni to read the following advice of Mr. Mendoza with regard to the use of these farm implements:

"Consider the matter thoroughly before introducing farm machinery into your farm and be sure then that you have plenty of cash on hand when you buy the machine, especially if it is to be used in rice fields."

Claro Samonte, '18, is at present a Provincial Agricultural Inspector of the Bureau of Agriculture stationed in Bayonbong, Nueva Viscaya. He writes that the province of Nueva Viscaya offers a good place for the graduates of the College if they want to go directly into farming. Mr. Samonte is married and is now the father of two husky "junior farmers".

In the recent Junior-Senior dual meet held last November, 1922, in the College of Agriculture, the Seniors proved superior to their opponents. They won the indoor baseball, volley ball and baseball and tied in the basket ball. The football is to be decided at some future time.

ACKNOWLEDGMENT

In his article "Concerning the Sugar Cane Root Parasite, Aeginetia indica," (Philippine Agriculturist **11**, 3, 89-90) Professor McWhorter accidentally omitted to acknowledge the source of the photographs from which the accompanying plates were made. They were taken by the Bureau of Science, Manila.

A man is like a tack: he can go only as far as his head will let him.